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Assessment of electrical stunning in fresh water of African Catfish (*Clarias gariepinus*) and chilling in ice water for loss of consciousness and sensibility

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Abstract

The overall objective of the study was to evaluate loss of consciousness and sensibility after electrical stunning in fresh water and live chilling in ice water for slaughter of African catfish using measurement of electrical brain and heart activity.

To provoke immediate loss of consciousness and insensibility, the minimum electrical current needed to induce a general epileptiform insult was assessed by placing a fish one by one in a tank between 2 plate electrodes in fresh water. The general epileptiform insult on the EEG (electroencephalogram) was characterised by a tonic, clonic and an exhaustion phase. After stunning, the ECG (electrocardiogram) revealed fibrillation. Within a confidence level of 95%, taking into account the number of animals with a reliable EEG ($n=24$), at least 88% of all catfish are effectively stunned in fresh water by an average current of 1.60±0.11 A/dm^2 (50 Hz, sinusoidal, a.c.) at a conductivity of 876 μS of the water. After electrical stunning in combination with decapitation the fishes showed minimal brain activity until death by bleeding.

For assessment of live chilling, 28 individual catfish kept in aerated tap water of 24 °C were placed one by one in ice water of 0.1±0.5 °C for 30 min. The fishes showed swimming followed by clonic muscle cramps and became motionless at the end. No response on pain stimuli on the EEG appeared after a median of 12.5 min (5 to 20 min) at a body temperature of 13.7±2.6 °C ($n=22$). When taking into account the number of animals with a reliable EEG ($n=22$) and using 95% confidence intervals, it was concluded that at least 87% of the catfish were unconscious and insensible at a decrease in body temperature of approximately 8.7 °C. Live chilling of African catfish resulted in an extremely high heart rate (tachycardia). Values between 294±47 and 311±38 beats/min ($n=13$) were measured, where a normal value is between 70 and 80 beats/min.

It was observed that unconscious and insensibility can be induced instantaneously by electrical stunning in fresh water. To kill the fish for slaughter decapitation is an option. Live chilling appeared to be a slow method. Whilst the African catfish was still conscious and sensible muscle cramps and tachycardia both occurred which may indicate stress.

Keywords: African catfish; Electrical stunning; Decapitation; Live chilling; EEG; ECG; Behaviour; Slaughter

1. Introduction

For the economic viability and sustainability of husbandry of animals, farming fish is an alternative and addition to meat production. Interest in sustainable

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farming of fish has emerged due to the problems associated with intensive livestock production, the increasing imbalance between amounts of fish caught (limited by EU quota) on one hand and an increasing consumer demand for a variety of high quality fish on the other hand.

Nowadays, quality of fish also comprises ethical aspects during production. Especially during pre-slaughter, welfare of fish can be compromised. For various farmed fish species in the Netherlands and other countries, death in air, live chilling, carbon dioxide narcosis and a manually applied blow on the head are used as pre-slaughter methods in the industry. Lambooij et al., 2002a,b; Robb and Kestin, 2002; Van de Vis et al., 2003 established that these pre-slaughter methods can be stressful. According to the EU Council Directive 93/119/EC (1993) on the protection of animals at the time of slaughter or killing, slaughter animals must be restrained in an appropriate manner to spare them any avoidable pain, suffering, agitation, injury or contusions. Permitted methods for stunning are: (1) captive bolt pistol, (2) concussion, (3) electronarcosis and (4) exposure to gas mixtures.

In contrast to warm-blooded food animals, there are no specific requirements for protection of fish at slaughter. Welfare of fish should also be given moral consideration, as there is evidence that fish can perceive pain and fear, since results of anatomical, physiological and behavioural studies were similar to those of studies performed on birds and mammals (Mathews and Wickelgren, 1978; Neuman, 1991; Kestin, 1994; Sneddon, 2002, 2003; Sneddon and Gentle, 2002). Contrary to the conclusions of these authors, Rose (2002) concluded that fish are not capable of pain and fear perception, as the necessary brain structure, a well developed neocortex, is not present in fish. In the view of Rose, the presence of the massive neocortex in organisms is required for cognitive capabilities. For perception of pain and fear a living organism should possess cognitive capabilities. In this respect it is suggested that fish have an ability to detect, conceptualise and respond to noxious stimuli. (Braithwaite and Huntingford, 2004; Chandroo et al., 2004). Especially, the application of pre-slaughter and slaughter methods can result in administering noxious stimuli to a fish, for instance decapitation of an eel that is still aware (Van de Vis et al., 2003).

The present status of pre-slaughter and slaughter methods that are used in fish processing, is leading to an increasing concern of government, animal protection associations and consumers. Fish can be protected at slaughter by applying effective stunning methods to provoke unconsciousness and insensibility as soon as possible and without a detrimental effect on the welfare of the animal and the meat quality of the carcass. Stunning of slaughter animals is in the first place applied to induce a state of unconsciousness and insensibility of sufficient duration to ensure that the animal does not recover while bleeding to death. Secondly, stunning should produce sufficient immobility to facilitate the initiation of exsanguination (Blackmore and Delany, 1988).

The current pre-slaughter process used in the Netherlands for African catfish consists of live chilling to immobilise them prior to evisceration (Robb and Kestin, 2002). Assessment of live chilling of eel revealed that this method is stressful as vigorous activity of the animals and an irregular heart rate were observed. Responses to pain stimuli disappeared at a body temperature of approximately 8.0 °C, which occurred after 12±5 min, which suggests that consciousness is lost (Lambooij et al., 2002a,b). It is doubtful that live chilling provokes unconsciousness in African catfish immediately and without avoidable stress, as it has been reported for carp (Arends et al., 1998), eel (Lambooij et al., 2003) and gilthead seabream (Van de Vis et al., 2003) that this is stressful. A method to provoke immediate loss of consciousness is electrical stunning, as its application induced an immediate loss of consciousness in Atlantic salmon, eel and gilthead seabream (Van de Vis et al., 2003).

The objective of the study was to evaluate an electrical stunning procedure to induce instantaneous unconsciousness and insensibility in African catfish (*Clarias gariepinus*) as an alternative to live chilling. Moreover, electrical stunning in combination with decapitation was assessed to establish and to render the catfish unconscious and insensible until death. The second objective of the study was the evaluation of behavioural, neural and physiological responses during live chilling. Both methods were assessed by neural (EEG), physiological (ECG) parameters and behavioural observations.

2. Materials and methods

2.1. Fish

Three days before the experiment batches of 30 African catfish were fasted and after that delivered to the laboratory. The catfish were kept in a tank containing aerated tap water at 24 °C. The experiment was performed with approximately 10 animals per day. After the experiment the fishes were weighed and dissected to determine the sex.